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Analysing the Vibratory Response of Micromirror using Different Material

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Abstract—*We can modify the damping response of micro mirror by shifting its frequency. We initially measure its thickness of viscous boundary coating then mirror will alter its effective damping at dissimilar points. We also examine its displacement response and its geometry modeling for various materials. Material of semiconductor is polysilicon, of polymer is polyimide, and of metal are gold, aluminium, and titanium. The result of our investigation shows the interface includes thermal and viscous damping explicitly as it solves the full liberalized Navier-Stokes, the displacement reaction by adjusts its center frequency.*

Keywords— DMD, MEMS

I. Introduction

Micro mirror systems are part of small MEMS (micro-electro-mechanical systems) systems for integrated scanning micro mirror systems. Various compressed visual displays devices consume micro mirror rotating about one or two axis. Mirror used to low power consumption, and for low cost of consumer application. Their range also from microscopic application, medical imaging. Also, for several DMD applications utilizing optical switches, projectors, head-up and head-worn displays, barcode readers, endoscopic cameras, and several features include to high reliability, wide bandwidth, and small weight attractive features. The dynamical characteristics of micro mirrors play a important role in the output performance of these systems. The dynamical response of a micro mirror is related to its Frequency and position, which may effect to its displacement.

According to requirement micro mirror is designed and manufactured based on application. But to achieve its design it should also specify its dynamical requirement.

In the study of displacement and frequency, introduce about its effective damping and power response with varying center frequency (f0) of the micro mirror. Different parameter are studying at different center frequency (on which it is respond) with different material .An important parameter is thickness of boundary layer (also called penetration depth) describe about its boundary layer thickness. Boundary thickness for every material will be changed. Boundary layer thickness depends upon its center frequency and calculated by 0.22[mm]*sqrt (100[Hz]/f0). Power response, displacement response, displacement mode will be change. These all the changes are actuated by full linearized Navier-Stokes, continuity, and energy equations.

The frequency sweep results in a frequency response where the displacement (or velocity) is evaluated at the tip of the mirror (on the symmetry plane). The response at the resonance yields the Q-factor Qr and the resonance frequency fr. Their expected values are given in the parameters list. The Q-factor is defined as

Q factor (frequency sweep) = $f0 / \Delta f$

where $f0$ is the resonance frequency and Δf is the peak width
The Q-factor is related to the attenuation rate α through

A=wo/2Q; w0= 2pi*f0

A mirror with high Q factor (low damping) dumps its energy slower factor should be less.

II. DESIGINING OF MICROMIRROR

In this designing we are looking about four different materials such as al, polyimide, gold titanium are using base material is polysilicon to check displacement response of the materials with respect to frequency. Other materials can give comparative result but in this work we are discussing about above four materials to check out the response of damping for every material and checking the comparison between the results. Polysilicon was using frequency at 8.5khz.To check its response we should calculate its centre frequency. After finds its centre frequency w will compute its result for study. These results tell us parameter response of viscous boundary limit. This parameter will be change for every material then other changes can justify and their effect for every material can compare to check best material.

Displacement Mode Result It specifies the Displacement of the micro mirror which is in vibrating mode and its displacement depends upon itsfrequency. In this micro mirror, two legs are attached and two legs are free and free legs can vibrate and can offer sharp image according to its application**.** But we should be careful for its frequency range that it should not crack the micro mirror and image should be proper. So we carefully check its high frequency and its lower frequency. Displacement will be proper then its power response (which shows that how much power is using), displacement response (which shows that how much displacement is using), table graph (which shows the output at different-different points according to input) will be proper. Then we can use to it in different-2 application.

Polysilicon:

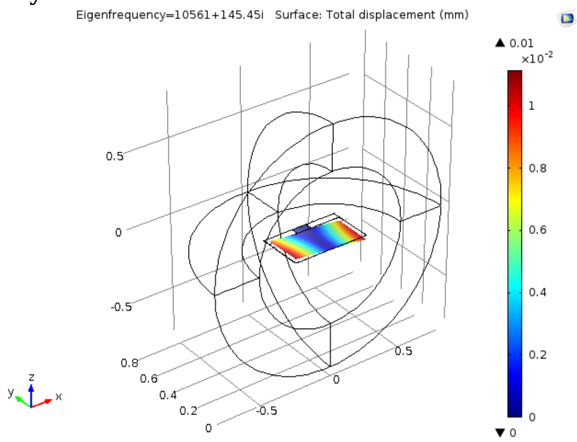

Figure 1 Displacement mode of Polysilicon

Aluminium- This material is giving response at center frequency 6.5khz.Center frequency tell us its upper half and lower half frequency.

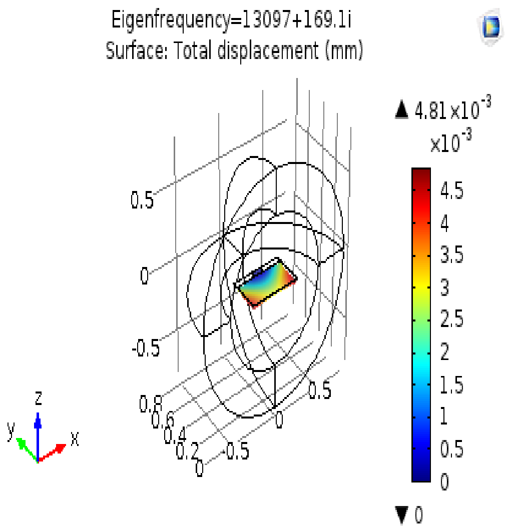

Figure 2 Displacement mode of Al

Polymide- This material is giving response at center frequency 1.5khz.Center frequency tell us its upper half and lower half frequency.

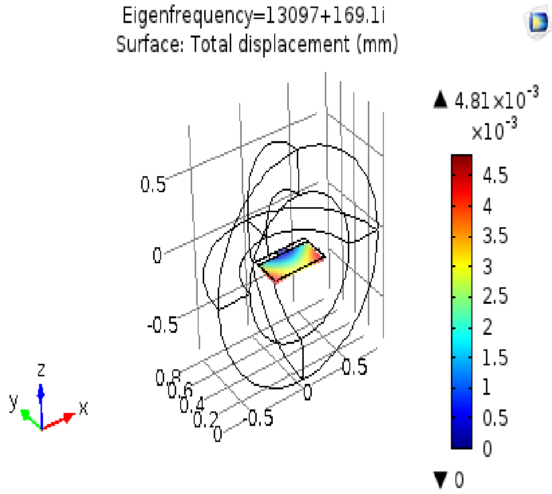

Figure 3 Displacement mode of Polymide

Titanium-This material is giving response at center frequency 6.5khz.Center frequency tell us its upper half and lower half frequency.

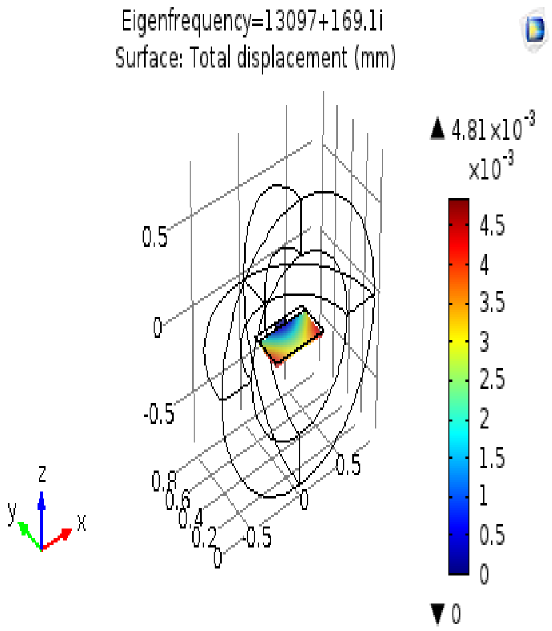

Figure 4 Displacement mode of Ti

Gold (2.5) - This material is giving response at center frequency 2.5khz.Center frequency tell us its upper half and lower half frequency.

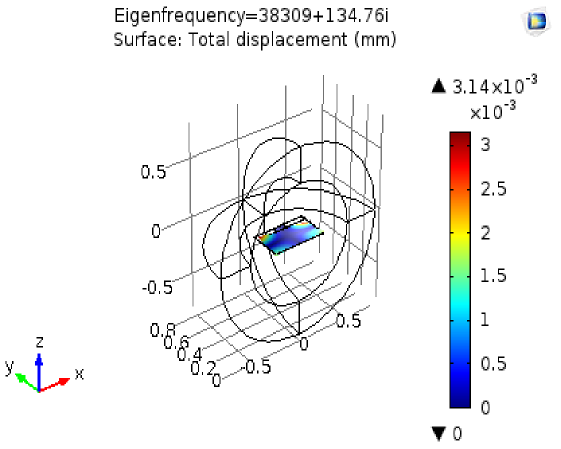

Figure5 Displacement mode of Gold

Displacement Response:

Polysilicon - In this response, this curve reflect that initially at frequency 1 kHz and at freq. 1.5khz curve response is increasing linearly after 1.6 kHz it is slightly changing then it is decreasing. So, useable part is till 6.5.Its bandwidth is 1000Hz.

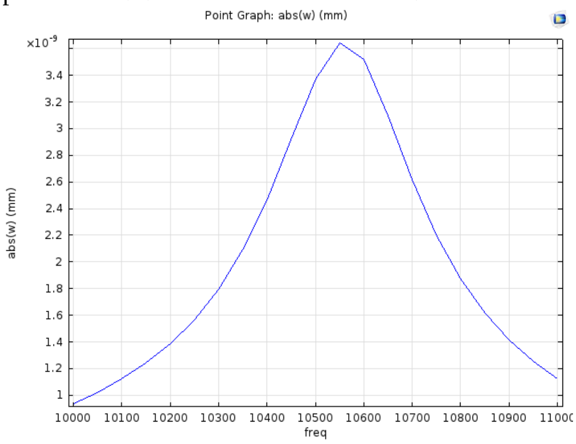

Fig 6 Displacement response of Polysilicon

Al - In this response, this curve reflect that initially at frequency 5.6khz and at freq. 6.2khz curve response is increasing linearly after 6.25khz then it is decreasing. So, useable part is till 6.5.Its bandwidth is1200Hz.

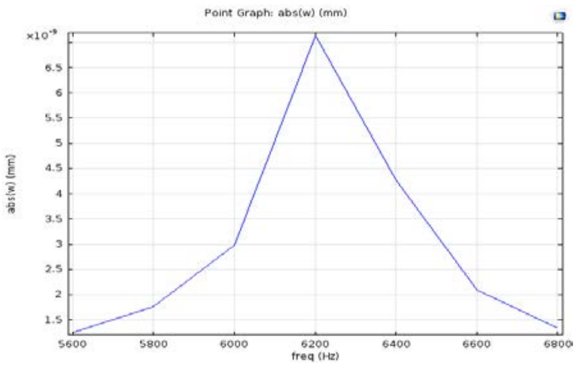

Fig 7 Displacement responseof

Polyimide(1.5-2) In this response, this curve reflect that initially at frequency 1khz and displacement 1 mm curve response is increasing linearly at 1.8 kHz it is slightly changing then it is decreasing. Its frequency is 1400Hz.

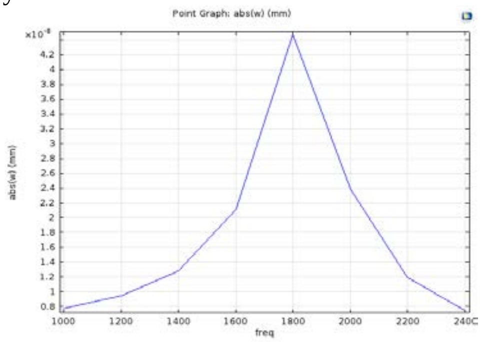

Fig 8 Displacement response of Polymide

Titanium(6.5) In this response, this curve reflect that initially at frequency 6khz and displacement 1.2 mm curve response is increasing linearly after 6.24 to 6.26khz it is slightly changing then it is decreasing. Its required area is 6kHz to 6.6khz.Its bandwidth is 600hz.

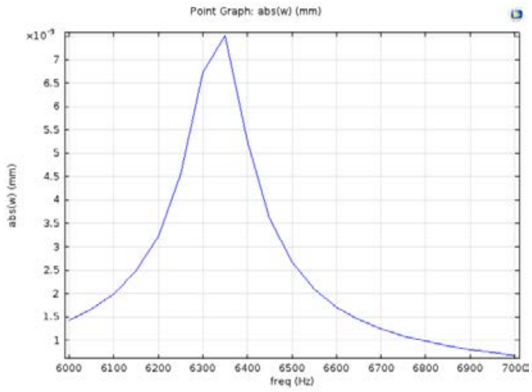

Fig 9 Displacement response of Titanium

Gold- In this response, this curve reflect that initially at frequency 2khz and displacement 0.3 um curve response is increasing linearly after 2.25 to 2.48khz it is slightly changing then it is decreasing. Its required area is 2.2kHz to 2.65khz.Its bandwidth is 300 Hz.

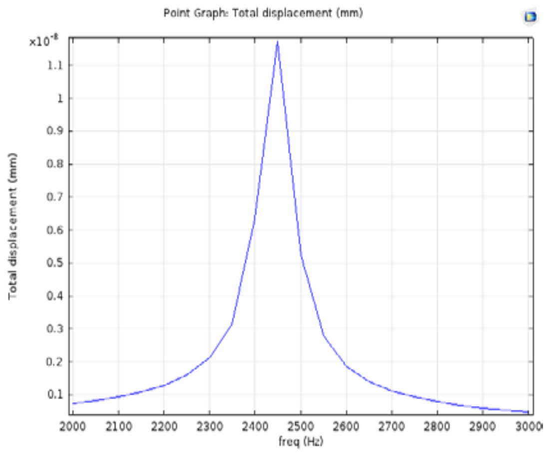

Fig 10 Displacement response of gold

III. Comparitive graph:

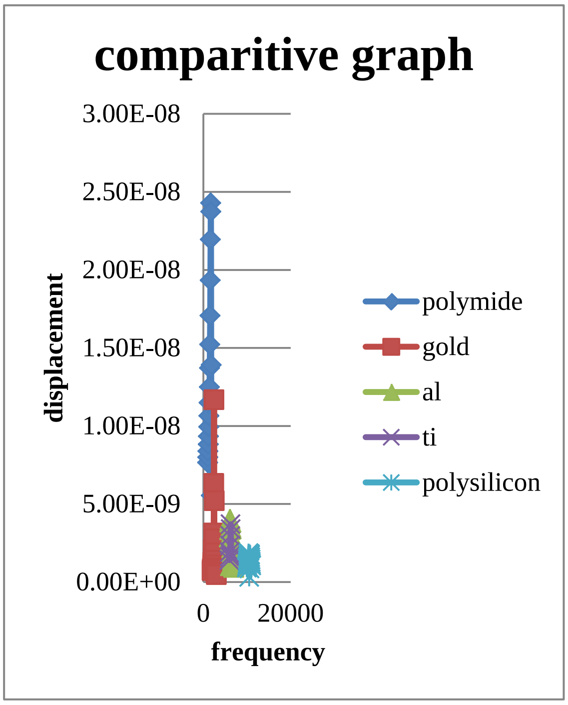

Fig:11 comparative graph

Frequency required for Polyimide is 1000hz to 1850 Hz. At this frequency range its step size varied 7.65E-09 to 5.54E-09.Gold frequency is 2000 to 3000.its step size displacement varied from 8.17E-10 to 4.79E-10.Frequency range is from 6000hz to 7000hz Its displacement is varied from 9.89E-09 to 9.41E-10.Titanium frequency range is from 6000hz to 6350Hz.Its displacement is from 1.40E-09 to 170E-09.Polysilicon use frequency range from 10khz to 11khz. Displacement is from 9.12E-10 to 1.06E-09.Polymide displacement is maximum in this comparison and operating at very low frequency. It is also conclude that frequency is inversely proportional to frequency. After this material gold is responsing, but its response is very linear it's increasing and decreasing time is much accurate out of four materials. Aluminium and Titanium are responding at same frequency so they are responding to merge data output. Its frequency range is high and response of displacement is poor. Polysilicon was using 10.5 kHz of its centre frequency but its response was poor damping.

IV. CONCLUSION:

On different material, at different centre frequency, above material are giving results for displacement. Gold is consuming 300 Hz bandwidth.Polysilicon is consuming 1000Hz.Polymide is consuming, Titanium is consuming 600Hz, is consuming, Polyimide is occupying 1400Hz,.Aluminiumis consuming1200Hz.So gold is consuming less bandwidth and giving response faster than other materials. Polyimide is giving maximum angle response.

V. REFERENCES

1) www.comsol.in